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ABSTRACT

A competency-based educational program for future physicians studying reproductive biology was developed at the University of Utah College of Medicine. The development took the form of a generic model specifying a linear sequence of steps, namely: assess competency needs, specify competencies, determine competency components and performance levels, identify and implement competency attainment procedures, establish assessment of competency attainment, and validate all system components. A functional analysis was performed on each of these steps. In the future it is hoped to eliminate a time-bound curriculum in the sophomore reproductive biology course and substitute a set of self-learning modules where students would learn content independently, using their own personal choices of method of teaching. (WH)

EXPERIENCES WITH A COMPETENCY-BASED EDUCATIONAL APPROACH TO REPRODUCTIVE BIOLOGY*

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A profession can claim professional standing only when explicit statements about what constitutes competence in that field and statements of strategies by which competence can be attained and assessed are available. The clarification of the concept of competence is not limited to medicine and does not represent a drastic departure from past lines of developmental work. It has sound conceptual and experimental roots. (1, 2)

Efforts by many research groups established the framework which has led to the proposal of a three-dimensional "competency pattern" model. These dimensions consist of: (a) needs assessment, job analysis and identification of critical tasks; (2) categorization of tasks and identification of skills and conceptual integration of task relationships for effective performances; and (3) theory derivation, definition and integration to provide perspective and the "cognitive maps" professional educators need to understand the tasks and select appropriate procedures and courses of action. (1, 2, 3)

The earlier efforts referred to above have made a significant new departure possible. Some of the inventions and developments that have taken us beyond earlier "competency pattern" models and forced a reassessment and redefinition are: (a) a general needs assessment and system theory that permits more precision and possibly more rigor while maintaining a humanistic perspective; (b) strategies that may permit the development of individualization and non-time-bound competency attainment; (c) use of differing methodologies that provide alternative routes to competence; (d) the development potential of evaluation models for measuring competency qualitatively rather than quantitatively; (e) the possibility of interdisciplinary cooperation -- medical education, administration, management, sociology, etc., that enhances the likelihood of defining with more specificity and clarity in training programs; and (f) improved linkages within the health sciences that make possible needs assessment, reality-oriented experiences, validation of program components, increase expectations for relevance, and increase recognition of legitimate means of continuing competency attainment once the field of practice has been entered. (1, 2, 3, 6, 7)

It is appropriate to define the meaning of the term "competency" as it relates to qualification. Competency is the presence of characteristics

or the absence of disabilities which render a person fit, or qualified, to perform a specific task or to assume a defined role. To be competent is to possess sufficient knowledge and ability to meet specified requirements in the sense of being able, adequate, suitable, and capable of a given task or role. (1, 2)

The general definition above contains two elements: (a) an identification for specification of the knowledge, ability, or other identifiable characteristics needed to perform tasks or roles; and (b) also, one must distinguish between the terms competence and creditability. Legal definitions are helpful in making such distinctions. A person can be legally competent but not give credible testimony. In a court the judge decides who is competent (qualified to give testimony); the jury decides whether the testimony is credible. (1, 2)

The application of the general system model for the identification of competencies and for the design of a program used in a reproductive biology course at the University of Utah College of Medicine is shown in Figure 1.

Figure 1. GENERIC MODEL FOR THE DEVELOPMENT OF A COMPETENCY-BASED EDUCATIONAL APPROACH.

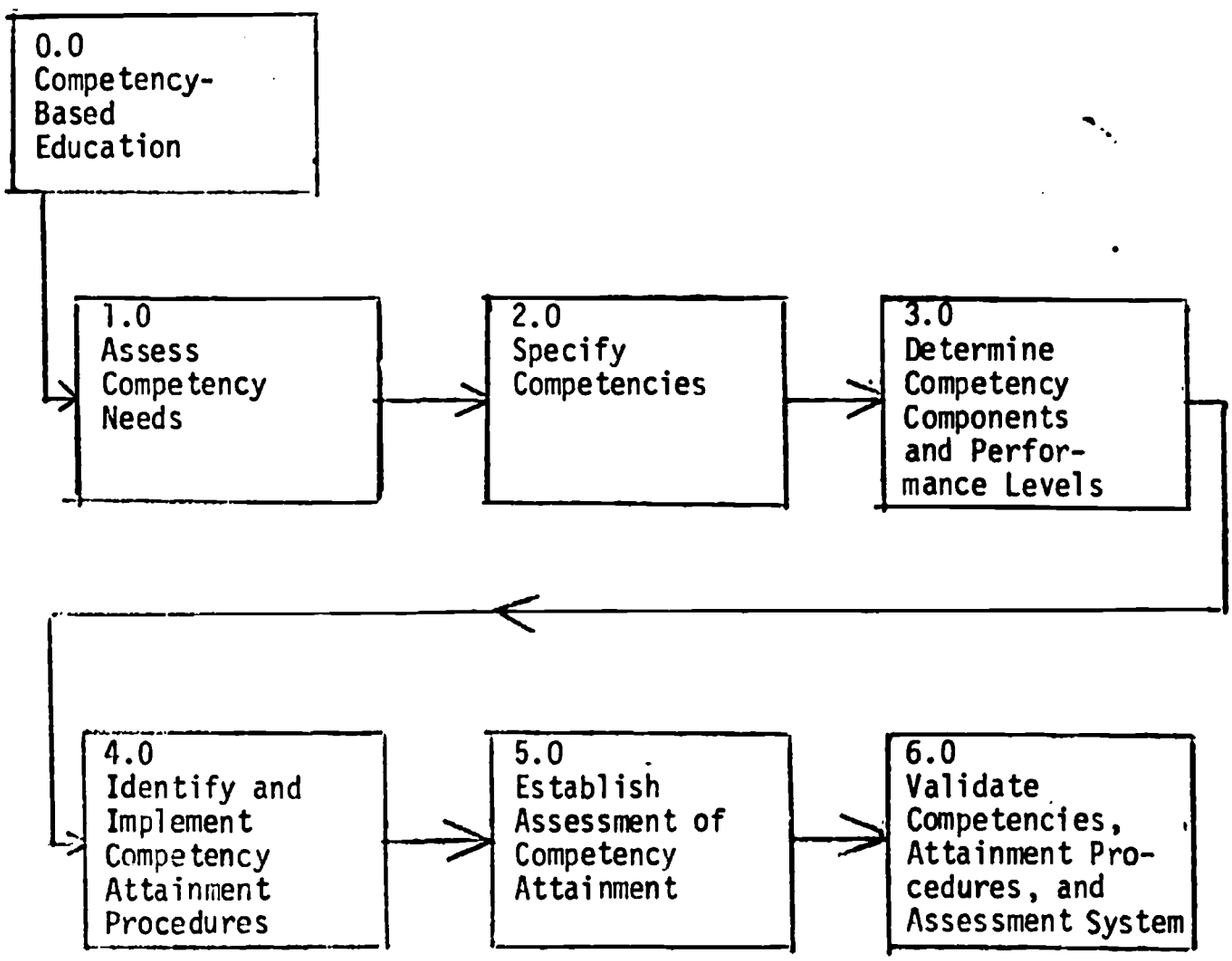
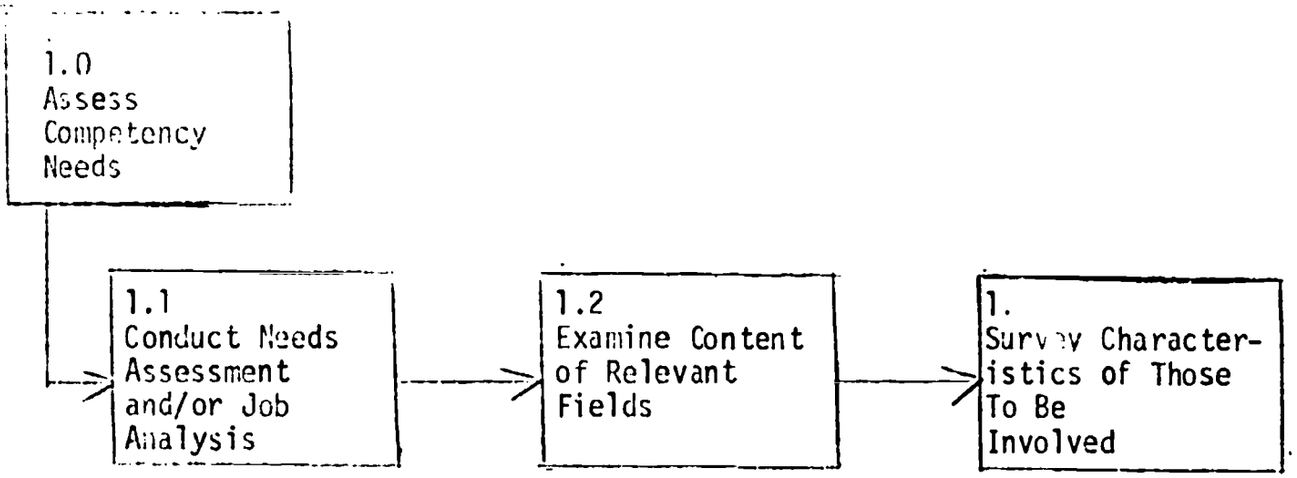


Figure 2 is an analysis of functions for assessing competency needs.

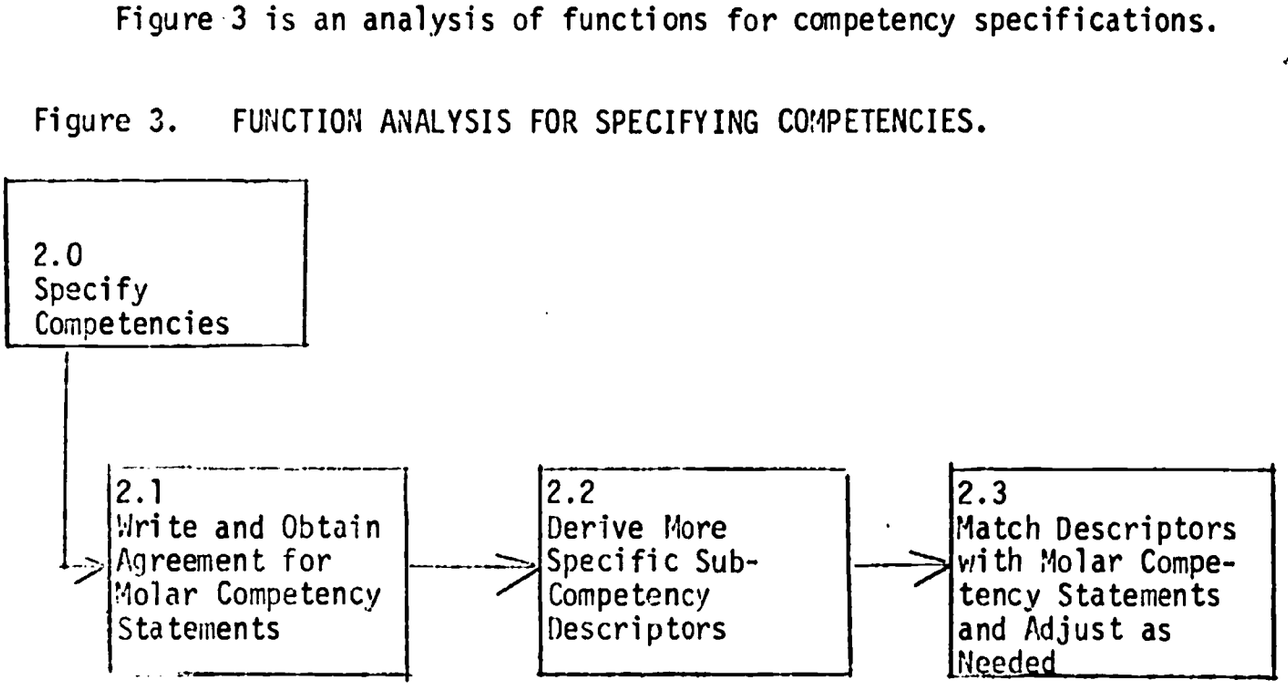
Figure 2. FUNCTION ANALYSIS FOR ASSESSING COMPETENCY NEEDS.



At the University of Utah, the faculty of several disciplines met to consider the need for and design of a course in reproductive biology for second-year medical students. These physicians all made practical application of the arts and sciences of reproductive biology as it contributes to patient care in medical settings. Discussions relating to the needs of patients and to tasks and content needed by physicians in this area for the benefit of patients were held. Medical students also contributed to these deliberations and, from this input, the characteristics and needs of learners were included in assessing competency needs.

Figure 3 is an analysis of functions for competency specifications.

Figure 3. FUNCTION ANALYSIS FOR SPECIFYING COMPETENCIES.

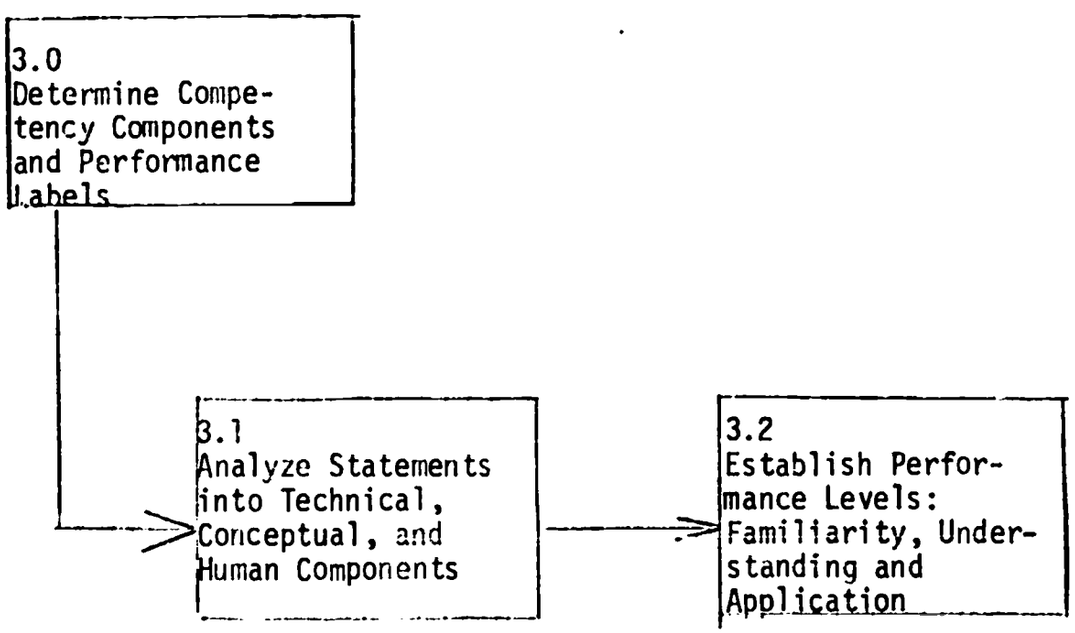


Perhaps the most difficult activity, but a very necessary one, is the actual writing of competency statements. The scope of the statement, its form and the elements to be included, all create "hang-ups". It is necessary to accept the idea that education (competency attainment) is an open system: (a) all possible competencies will never be identified and some can only be vaguely identified; (b) some competencies will not have any identifiable means of attainment; and (c) some will seem extremely simple and mundane while others will appear to be so complex as to be unrealistic. Best progress has been made when statements are molar in form, that is, they represent an identifiable competence that involves technical, conceptual and human components. (1, 2)

One such statement for a sophomore course in reproductive biology is presently being used at the University of Utah College of Medicine. The statement is cast in a form that reads: "The physician in training needs to be able to understand the biological and psychological mechanisms related to human reproduction." The statement pointed to a performance expectation that need not be detailed at this point. In the illustration above, the statement concludes, "...understand the biological and psychological mechanisms related to human reproduction." This clause contains a performance expectation. This competency statement, in molar form, represented that which the faculty and students had decided, based on reference to patient needs, was necessary for all physicians-in-training to obtain in their sophomore year and the competency statement was accepted as generic or basic for the education of a physician. (2)

The process for determining competency components and performance labels is demonstrated in Figure 4.

Figure 4. FUNCTION ANALYSIS FOR DETERMINING COMPETENCY COMPONENTS AND PERFORMANCE LABELS.



At the familiarity level, subcompetency statements were derived as follows: (a) Technical competency: The physician-in-training needs to be able to identify basic anatomic features of those organs related to male

and female reproductive systems; (b) Conceptual competency: The physician-in-training needs to be able to identify both male and female biochemical and physiological characteristics related to reproduction; (c) Human competency: The physician-in-training needs to be able to identify maturation processes in males and females. (2)

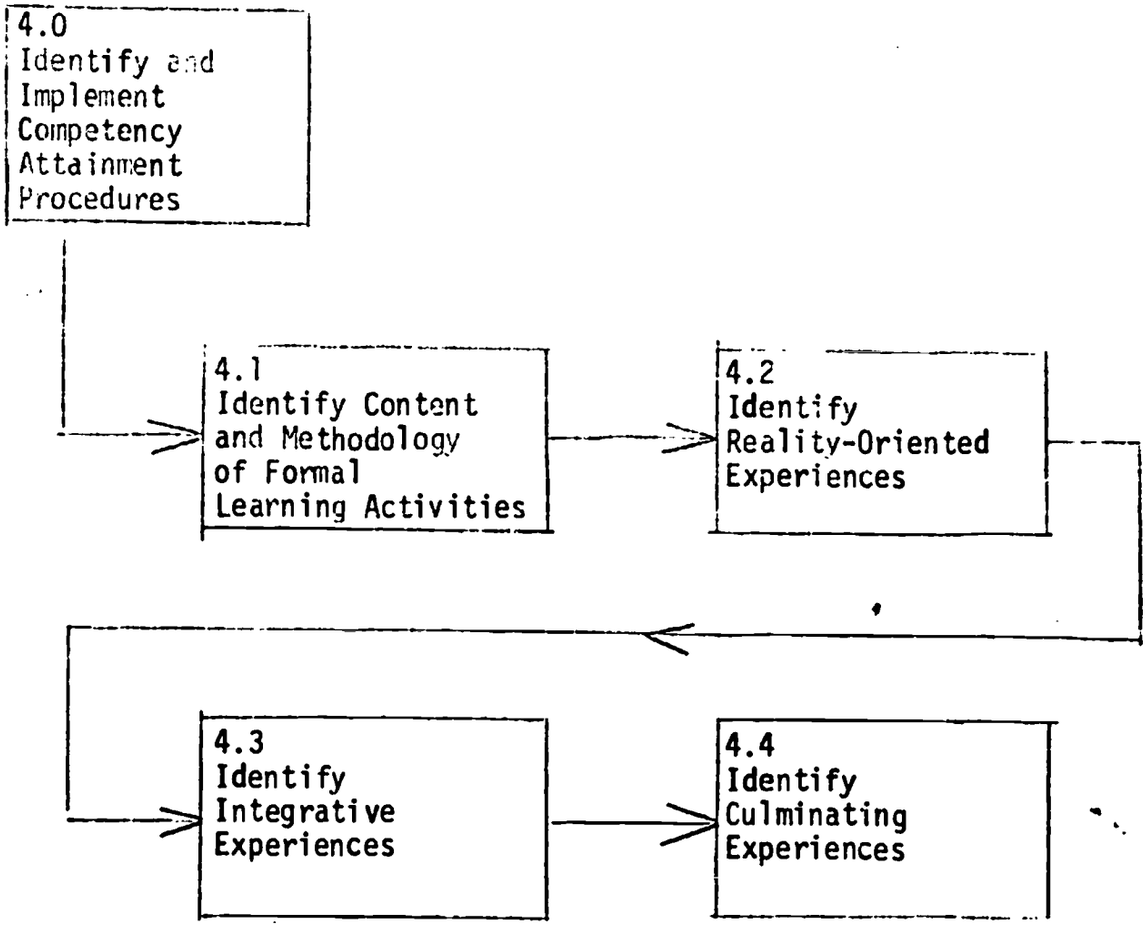
At the understanding level, subcompetency statements were derived as follows: (a) Technical competency: The physician-in-training needs to be able to describe the interrelationship of the anatomic aspects of organ systems involved in the reproduction cycle; (b) Conceptual competency: The physician-in-training needs to be able to describe the integration of biochemical, physiological and anatomical aspects of reproduction; and (c) Human competency: The physician-in-training needs to be able to describe male and female biological drives and emotional reactions to human sexuality as such forces relate to reproduction and to the interruption or delay of reproduction. The application of technical, conceptual, and human competencies learned by the physician-in-training, was determined to be not appropriately a part of the content to be learned in the sophomore year. Therefore, the derivation of subcompetency statements at the application level was reserved for later educational experiences -- probably best learned through clinical clerkships where physicians-in-training combine the theory of reproductive biology with on-going patient contact. (2)

During weekly planning sessions, faculty looked at competency statements and performance levels. Several derived more precise subcompetency statements and test questions for content areas for which they accepted teaching responsibility. Others preferred to write out test questions to represent their expectations of terminal student behavior and which were translated into subcompetency statements. A pre- post-test was developed from faculty questions submitted. In addition, a student profile form and a student course evaluation form were produced.

Upon completion of these tasks, the subcompetency statements were compared with the six competency statements derived earlier. Each faculty member and student representative viewed, regrouped and determined if the subcompetency statements were appropriate. In a very short period, the work was completed and all competency statements were judged valid as they all included the subcompetency statements. Total agreement as to content and performance expectations was thus validated by faculty and student representatives.

Means to attain competency were then initiated as shown in Figure 5.

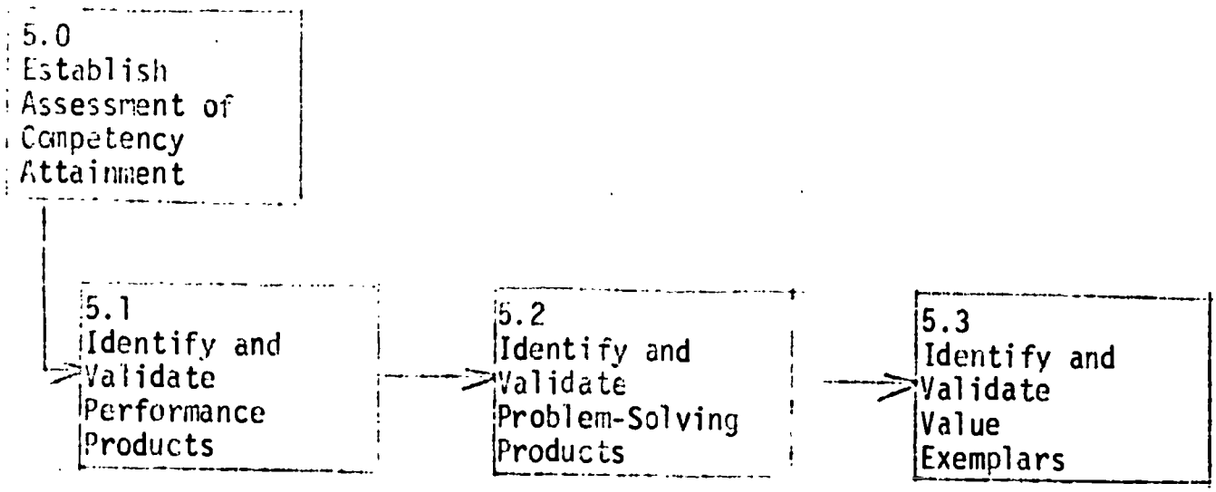
Figure 5. FUNCTION ANALYSIS TO IDENTIFY COMPETENCY ATTAINMENT



A schedule was set integrating the course as part of a new second-year curriculum utilizing an organ systems approach. A syllabus including sub-competency statements, readings, case studies, and recommended readings was developed and printed for each student. Faculty presentations were implemented. In addition to formal lectures, question and answer periods were scheduled. Several times during the course, panels were used to add depth and inter-disciplinary input to discussion of case studies. Students were asked to seek out faculty for subject areas in which they wished special tutorials for reality-oriented and integrative experiences. Some students formed study groups while other students simply skipped scheduled activities and used their syllabus and library sources for self-study purposes. Only the first session, where profiling and pre-testing were completed, and the final session, where post-test and student evaluation instruments were used, was "required". This then allowed for student selection of "alternative" pathways to learning within a broad time spectrum.

Competency attainment strategies are shown in Figure 6.

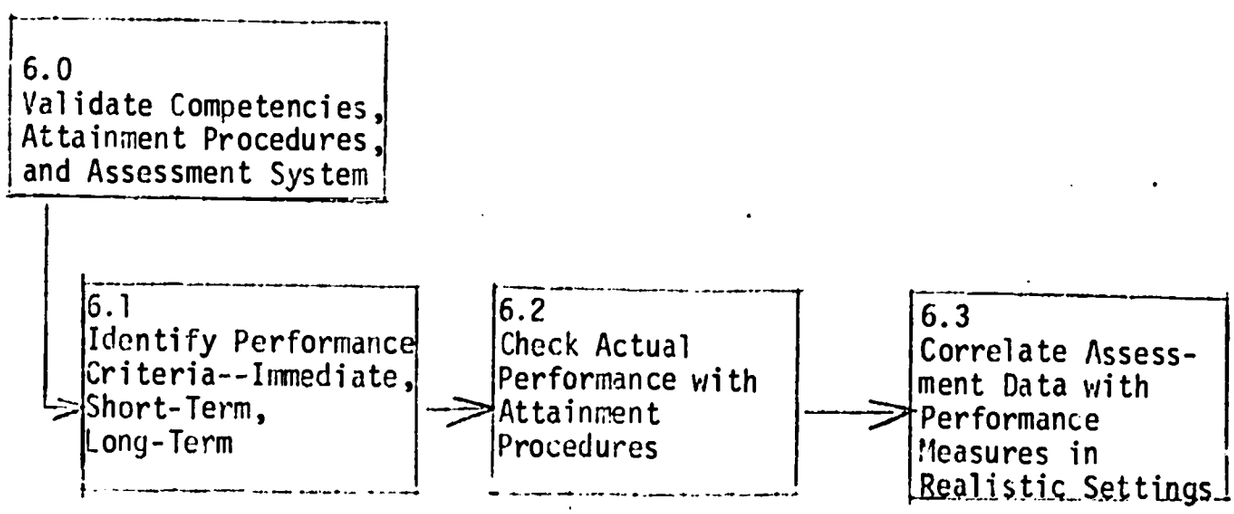
Figure 6. FUNCTION ANALYSIS TO IDENTIFY COMPETENCY ATTAINMENT



On the initial contact, students were asked to complete a competency profile sheet. They were asked to check off on each competency statement at the familiarity and understanding level (six statements in all): (a) if they did not yet possess competency (0 points); (b) if they were familiar with competency (1 point); (c) if they understood competency (2 points); (d) if they could apply competency on patients (3 points). A score was then derived for each student where the maximum possible was 18 and the minimum was zero. They were also pre-tested on content. Student profile scores and pre-test scores, identified by Social Security numbers, were communicated to students. It was hoped that large discrepancies in the score comparisons would provide students with feedback about the reality of their own self-scored profiles, as compared with their pre-test performance. Thus, the competent student in content who scored his profile low, would be less tense and, possibly, more willing to enhance learning through self-selected methodologies. In addition, it was hoped that the less competent student who scored his profile high would know that a great deal of effort must be expended to "do well" in the course.

Figure 7 demonstrates the process for evaluation and program evaluation.

Figure 7. FUNCTION ANALYSIS TO VALIDATE COMPETENCIES, ATTAINMENT PROCEDURES, AND ASSESSMENT SYSTEM.



A total of 99 of 100 eligible students took the pre- and post-test. A statistically significant gain ($p > .001$) occurred in their knowledge base. Short-term performance was achieved. In addition, as indicated earlier, comparisons by students of their pre-test scores with their profile scores, gave them nearly immediate information on their entry-level competence. However, item analysis, now in progress, has shown some items of the post-test to be unreliable. The KR-20 statistic to ascertain reliability revealed a .49 KR-20. In addition to difficulty level, an analysis of high versus low scorers using chi-square analysis, is in progress. More work on the post-test was indicated as a need.

Other than testing and attitudinal studies, we could not adequately assess some sub-functions noted. Possibly, through simulation techniques, it will be possible in the future to add more reality to the course. However, as a beginning, an attempt was made to find some answers through use of statistical procedures.

A correlation of student performance and student evaluation of learning activity for over three years was used, based on the assumption that zero correlation should be expected. (4, 5) Table 1 further demonstrates the viability of this approach.

It was of interest to note that students were most impressed by the syllabus. Such likes did not correlate with performance. Students were most critical of pre-course competency profiling and pre-test feedback. Again, dislikes did not correlate with performance.

Conclusions are tentative at this point. While faculty are aware of, and wish to respond to, student preferences whenever feasible, these data indicate that such likes or dislikes did not relate to student performance in this case. These data also suggested a large range of student evaluation scores across all activities. This supports the notion that individuals differ in their learning tastes and that all learners need options using a variety of learning strategies. (6, 7)

The final aspect of the approach will be longitudinal in nature. As students enter the third year, studies can relate what was found in this study with their performance on clinical rotations. For example, using the American Association of Obstetricians and Gynecologists' Entry-Level Test, given on the first day of the clerkship, it will be possible to independently measure for retention on an independent measure.

It is now possible to write application competency and subcompetency statements and use them to replace, or in conjunction with, molar statements and subcompetency statements of a similar nature already in use for third-year clerks in obstetrics and gynecology clerkships. Ideally, an integration of the two programs is now feasible.

It is also now known where areas of probable strengths and weaknesses exist in student attitudes and understanding level regarding content. This information should allow adjustment in the organ systems reproductive biology course and third-year clerkships, based on better information than was previously available. Clinical teaching programs to meet student needs,

Table 1. CORRELATION OF STUDENT PERFORMANCE AS MEASURED BY THE POST-TEST AND STUDENT ACTIVITY EVALUATION POST-COURSE FOR A REPRODUCTIVE BIOLOGY COURSE

Activity	Response	Mean	Standard Deviation	Range	Rank	Pearson r Statistic	Co-Variance
Syllabus	97	83.8	8.788	60.-100.	1.0	.07	3.40
Presentations by Faculty	95	80.1	7.685	60.- 95.	2.0	.18	7.72
Readings You Found on Your Own	74	79.2	9.322	50.- 95.	3.0	.08	3.68
Study Notes You Took of Lectures and/or Readings	87	78.8	10.078	50.- 95.	4.0	.11	6.48
Study Notes Shown to You by Other Students	34	75.4	12.533	50.-100.	5.0	-.01	-.34
Informal Contact with Course Faculty	32	74.6	12.412	50.- 95.	6.0	.14	8.90
Faculty Recommended Readings	44	74.0	11.646	50.- 90.	7.0	.17	8.67
Participation in Self-Formed Study Groups	14	73.6	15.403	50.-100.	8.0	-.26	-19.13
Readings Recommended by Fellow Students	27	73.4	12.821	49.- 95.	9.0	-.10	-6.79
Competency Profile and Pre-Test Feedback	91	64.9	13.103	40.- 95.	10.0	-.12	-8.50

both in cognitive and affective areas, should be more relevant. New techniques to add more individualized access to content and the possibility of allowing greater flexibility in a time-bound curriculum are becoming visible, based on what was found in this experience with a competency-based educational approach to reproductive biology.

With experience, it may be possible, in later years, to eliminate a time-bound curriculum in the sophomore reproductive biology course and substitute a set of self-learning modules where students would learn content independently, using their own personal choices of method of learning. Once a student, or a small group of students, demonstrates and documents an approach acceptable to the faculty, terminal measures can be utilized to determine if requirements were met. This then would allow a non-time-bound system of learning. However,

use of newer technologies, e.g., video-taping of didactic sessions, faculty coordination of each learner's individual method, would be a prerequisite. Limitations on faculty time and a lack of resources to purchase technical assistance for developing alternative learning systems that are educationally defensible are problems which must be overcome to fully implement such an ideal. In times of decreasing funds for medical educational innovation, the road ahead shall not be smooth, though a sincere desire on the part of students, faculty and administration could bring about improved experiences for the learning of reproductive biology in a medical school setting.

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